UNC Children's Clinical Practice Guideline
Pediatric Community-Acquired Pneumonia
Page 1: Overview

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Contents

How to use this guideline
This document provides *guidance* in management, including diagnostic evaluation, antimicrobial therapy, procedural management, and disposition, of children with community-acquired pneumonia (CAP). **It is not intended to replace clinician judgment in individual cases**; however, it should apply to the vast majority of patients diagnosed with CAP. This guideline does not address other pulmonary infections such as COVID-19, bronchiolitis, or tuberculosis.

Population
Inclusion criteria: children ≥60 days and ≤18 years of age with concern for community-acquired pneumonia (CAP) and treated at UNC Children's Hospital or affiliated clinics.

Exclusion criteria:
- Immunocompromised status (malignancy, autoimmune disease, primary immunodeficiency, HIV infection, bone-marrow or organ transplant recipient)
- Sickle-cell disease
- End-stage renal disease
- Severe underlying pulmonary disease (such as cystic fibrosis or oxygen requirement at home)
- Cyanotic congenital heart disease
- Neurologic or neuromuscular disease that affects respiratory function (such as cerebral palsy, cervical spinal cord injury, or muscular dystrophy)
- Presence of artificial airway, with or without need for supplemental oxygen or ventilator support
- Any condition that, in the view of the care team, significantly increases the risk of adverse outcomes of CAP

Use of MRSA Screening
MRSA screening at UNC is done by nasal swab. It is done by PCR for age ≥2 years (turnaround ~3 hours) and by culture age <2 years (turnaround ~48 hours) accurately predicts risk of *pneumonia* due to MRSA, but not other infection types. MRSA screening should *not* be used when suspicion for MRSA is low, such as routine CAP of mild or moderate severity. MRSA screening is also not recommended if the diagnosis of pneumonia is uncertain.

Important Distinctions
Sepsis: Sepsis is defined according to UNC Children's Sepsis Pathways. When a patient is identified as having sepsis, Sepsis Pathways take precedence over this document.
Severity of pneumonia: Definitions can be found on Page 2. Pneumonia is divided into "Mild," "Moderate," and "Severe." Most patients with mild pneumonia do not require admission to the hospital. Most patients with moderate or severe pneumonia are hospitalized.
Complications of pneumonia: These generally refer to intrathoracic complications, including significant parapneumonic pleural effusion, pleural empyema (infection within the pleural space), and intraparenchymal lung abscess.

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Page 2: Uncomplicated CAP

Inclusion Criteria
- Age ≥60 days to 18 years
- Healthy without major underlying conditions

Exclusion Criteria
- Aspiration risk
-Immunocompromised
- Sickle-cell disease
- Recent hospitalization (<30 days)
-Underlying neuromuscular disease or lung disease other than asthma
-Tracheostomy

START Initial Clinical Findings Concerning for CAP?

YES → Concern for Sepsis?

YES → Proceed with evaluation per Code Sepsis. If pneumonia considered, evaluate as recommended below under "Severe"

NO → Concern for Sepsis?

NO → OFF Algorithm

NO → Determine Severity of Pneumonia (see below)

MILD

Discharge home
-Recommended respiratory testing: Rapid PCR for flu/RSV/COVID-19
-Start PO antibiotics (see Page 5: Antibiotic Selection)
-Abx duration: 5-7 days
-Arrange follow up

MODERATE

Admit to pediatric floor
-Recommended respiratory testing: RPP with COVID-19
-Start IV antibiotics (see Page 5: Antibiotic Selection)
-Obtain 2-view CXR
-Obtain blood culture only if patient progressing to severe or complicated pneumonia

Severe features develop? → **SEVERE**

Admit to PICU**
-Recommended respiratory testing: RPP with COVID-19
-Start IV antibiotics (see treatment guideline)
Diagnostic Tests:
-Obtain 2-view CXR, CBC diff, BMP, blood culture, MRSA screen
-Respiratory culture if intubated
Note: May go to **intermediate bed if **ONLY** severe feature is requiring HFNC. Requires approval of admitting attending.

Concern for significant pleural effusion or lung abscess?
- YES → Proceed to Page 3: Complicated pneumonia
- NO → COVID-19?
  - YES → Proceed to Pediatric COVID-19 Guidelines
  - NO → Influenza?
    - YES → Proceed to Page 4: Influenza
    - NO → RPP positive for Pertussis, Mycoplasma pneumoniae, or Chlamydia pneumoniae?
      - YES → Start Azithromycin, continue algorithm
      - NO → Assess continously. Patient improving?

Pneumonia Severity Assessment
Note: if overlapping, assign more severe category

	MILD	MODERATE	SEVERE
General Appearance	Well-appearing or mildly ill	Ill-appearing	Toxic or lethargic
Oxygen Requirement	None	Standard nasal cannula	HFNC or non-invasive or invasive ventilation
Signs of respiratory distress	None or minimal	Moderate retractions, head bobbing, and/or nasal flaring	Severe retractions, head bobbing, and//or nasal flaring
Signs of sepsis?	Absent	Absent	**Present**
Hydration status	Able to maintain adequate hydration	Unable to maintain adequate hydration	Unable to maintain adequate hydration

Assess continously. Patient improving?

NO → **Considerations for patients who fail to improve**
-Alternative diagnosis, such as a separate infection wtih pulmonary manifestations
-Antibiotic resistance
-Consider sending MRSA PCR
-Development of lung abscess or empyema
-Uncommon pathogen (e.g., Legionella, mycobacteria including TB, fungal infection such as histoplasmosis)
-Immunocompromised state (e.g., HIV)

YES (Floor) → Discharge Criteria:
-stable on room air
-tolerating PO

YES (PICU) → -Transfer to pediatric floor
-Consider de-escalation of antibiotics (see treatment guideline)

→ **Discharge**

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Page 3: Complicated CAP

START
Complicated pneumonia suspected

If not already done: send RPP-COVID test

Concern for lung abscess? (abnormal clearance, air-fluid levels, etc.)

YES

NO

Moderate or large pleural effusion (>1/4 of hemithorax)

Evaluate with chest US. Loculations / complex fluid?

YES

NO

Continue treatment for uncomplicated CAP. Consider thoracentesis only if significant respiratory compromise. Re-evaluate as needed with CXR and/or US.

Criteria for "Complicated CAP"
Community-acquired pneumonia plus any of:
-Suspicion of lung abscess
-Pleural effusion >1/4 of hemithorax
-Pleural effusion with complex fluid

Initial Management of Empyema	
Labs	CBC/diff, CMP, CRP, blood culture. MRSA screen if requiring ICU.
Consults	Pediatric Surgery, Pulmonology, ID
Antibiotics	See page 5 for details. Use oseltamivir or remdesivir for patients with influenza or COVID-19, respectively.
Imaging	Following initial US, additional imaging not routinely required. Chest CT with contrast in selected cases (e.g., to rule out lung abscess), in consultation with Pediatric Surgery.

Procedural Management of Empyema

- Preferred option: chest tube to be placed by Pediatric Surgery, with or without video-assisted thoracoscopic surgery (VATS) depending on duration of symptoms.
- tPA instillation Q24 hours x 3 doses should be given after chest tube placement.

Send pleural fluid for Gram stain and culture, cell counts (AFB and fungal cultures if suspected). Optional: pH, glucose, LDH

Worsening

If worsening or not improving by 72 hours, ***consider*** the following:
-Recheck CBC/diff, CRP, imaging
-MRSA PCR if not already done
-Progress to VATS procedure if not done primarily

Worsening

Consultants and Primary Team Huddle

Improving

-Adjust antibiotics as appropriate

-Discontinue chest tube when drainage <2 ml/kg/12 h for 24 hours AND no air leak

-Transition to PO antibiotics

Initial Management of Necrotizing Pneumonia / Lung abscess	
Labs	CBC/diff, CMP, CRP, blood culture, MRSA screen. If intubated, send ETT aspirate for culture.
Imaging	CT chest with contrast
Consults	Pediatric Surgery, Pulmonology, ID
Antibiotics	See page 5 for details. Use oseltamivir or remdesivir for patients with influenza or COVID-19, respectively.

Ongoing Management of Necrotizing Pneumonia / Lung abscess	
Supportive Care	Admit to ICU or floor as indicated.
Differential Diagnosis	Consider atypical causes, such as TB, infected CPAM, FB aspiration, vasculitis
Labs	As indicated; suggest monitoring every 2-3 days or more as needed.
Imaging	As indicated; repeat CT rarely indicated
Procedures	Rarely indicated due to risk of bronchopleural fistula
Antibiotics	See Page 5 for details. In most cases, prolonged antibiotic duration of 4-6 weeks, generally IV for most of inpatient course. Antivirals per protocol.
Note: Improvement is usually gradual, and some initial worsening can occur.	

Improving

Assess Discharge Criteria
-Clinically improved
-Pain well-controlled
-Off oxygen x 12+ hours
-Fever curve downtrending
-CRP downtrending
-Tolerating home antibiotics

Worsening

Consider:
-Re-evaluate differential diagnosis and antibiotics
-Repeat inflammatory markers
-Repeat imaging
-**Consultants and primary team huddle**

Discharge Planning
-Set antibiotic duration (see page 7); recommend having meds in hand at discharge
-Follow-ups: Pulm, Surg, ID (ID will generally be for abscess only)
-Flu shot at discharge if indicated

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Page 4: Influenza

START
Upper or Lower Respiratory symptoms present with suspicion for influenza?

YES → Admission anticipated?

NO → Obtain Rapid Flu/RSV/COVID-19 PCR

YES → Obtain Respiratory Pathogen Panel (RPP) with COVID-19

Obtain Rapid Flu/RSV/COVID-19 PCR → Influenza result

Obtain Respiratory Pathogen Panel (RPP) with COVID-19 → Influenza result

Please refer to institutional COVID-19 testing guidelines for the most updated testing guidance. Manage as symptomatic patients.

Influenza result:
- POSITIVE → Admission planned?
- NEGATIVE → Continue evaluation and management as appropriate

Admission planned?
- NO → Treat with oseltamivir if patient meets high-risk criteria in **Box B**

  Consider oseltamivir in patients presenting within 48 hours of symptom onset without high-risk criteria
- YES → Antiviral therapy. **Can** patient receive enteral medications? Includes PO, NG, NJ, G-tube

Antiviral therapy. **Can** patient receive enteral medications? Includes PO, NG, NJ, G-tube
- YES → Start oseltamivir (MOST patients)
- NO → Start IV peramivir. This is rarely necessary. ID Consultation strongly recommended.

NOTE:
In admitted patients with **no** high-risk conditions with primary concern for hydration status, clinicians may choose to defer antiviral therapy.

Start oseltamivir (MOST patients) / Start IV peramivir → Assess need for antibiotic therapy

Assess need for antibiotic therapy → If intubated or artificial airway, obtain tracheal aspirates for culture → ICU admission for respiratory failure or sepsis?

NOTE:
Some patients with influenza may have other indications for antibiotics. Examples include:
- Infant <60 days
- Neutropenia due to chemotherapy
- Central venous catheter
- Transplant recipient

Antibiotics should be given when appropriate in such cases.

ICU admission for respiratory failure or sepsis?
- YES →
  - Consult Infectious Diseases.
  - Obtain MRSA screen

  MRSA screen positive or pending → Start linezolid plus ceftriaxone

  MRSA screen negative → Start ceftriaxone

  Start linezolid plus ceftriaxone / Start ceftriaxone → Assess daily for de-escalation of antibiotics based on clinical course and culture results. Complete oseltamivir course.
- NO → **ANY of the following?**
  - Lobar consolidation
  - Pleural effusion
  - Failure to improve after >72 hours
  - Deterioration after initial improvement
  - Immunocompromised host

  YES → **Consider:**
  - MRSA screen
  - addition of antibiotics for uncomplicated CAP
  - Infectious Diseases consultation

  Complete oseltamivir course.

  NO → Complete oseltamivir course

Drugs for Influenza
Oseltamivir:
<12 months: 3 mg/kg/dose BID
≤15 kg: 30 mg BID
15-23 kg: 45 mg BID
23-40 kg: 60 mg BID
>40 kg: 75 mg BID
Usual duration 5 days; in severe illness 10 days has been used. Most common side effects: nausea and vomiting.

Peramivir (Requires Infectious Diseases approval):
≥2 years: 12 mg/kg up to 600 mg IV. For younger patients, consult Pediatric Infectious Diseases. **Usual duration is a single dose**; 5-day courses have been given in severe disease.

Box A: Influenza Season
November 15 - March 30
OR
As defined by CDC (https://www.cdc.gov/flu/weekly/) or Hospital Epidemiology

Box B: High-Risk Patients
Any of the following:
- <2 years of age
- Immunocompromised
- Pregnant
- Chronic pulmonary disease, including asthma
- Chronic cardiovascular disease (symptomatic)
- Chronic renal disease
- Chronic liver disease
- Chronic hematologic disease, such as sickle-cell disease
- Metabolic disease, including diabetes mellitus
- Neurologic/developmental conditions (epilepsy, cerebral palsy, spinal cord injury, etc.)
- Obesity (BMI > 99th %ile)

Box C: Diagnostics
Rapid COVID-19 + Influenza A/B + RSV PCR:
- Turnaround: 60 min
- Sensitivity: >99%

Respiratory Pathogen Panel + COVID:
- Turnaround: <4 hours
- Sensitivity: >99%

Note: See hospital testing guidelines for most updated preferences. Lab is unable to add RPP-COVID onto rapid test. AVOID sending rapid test followed by RPP-COVID.

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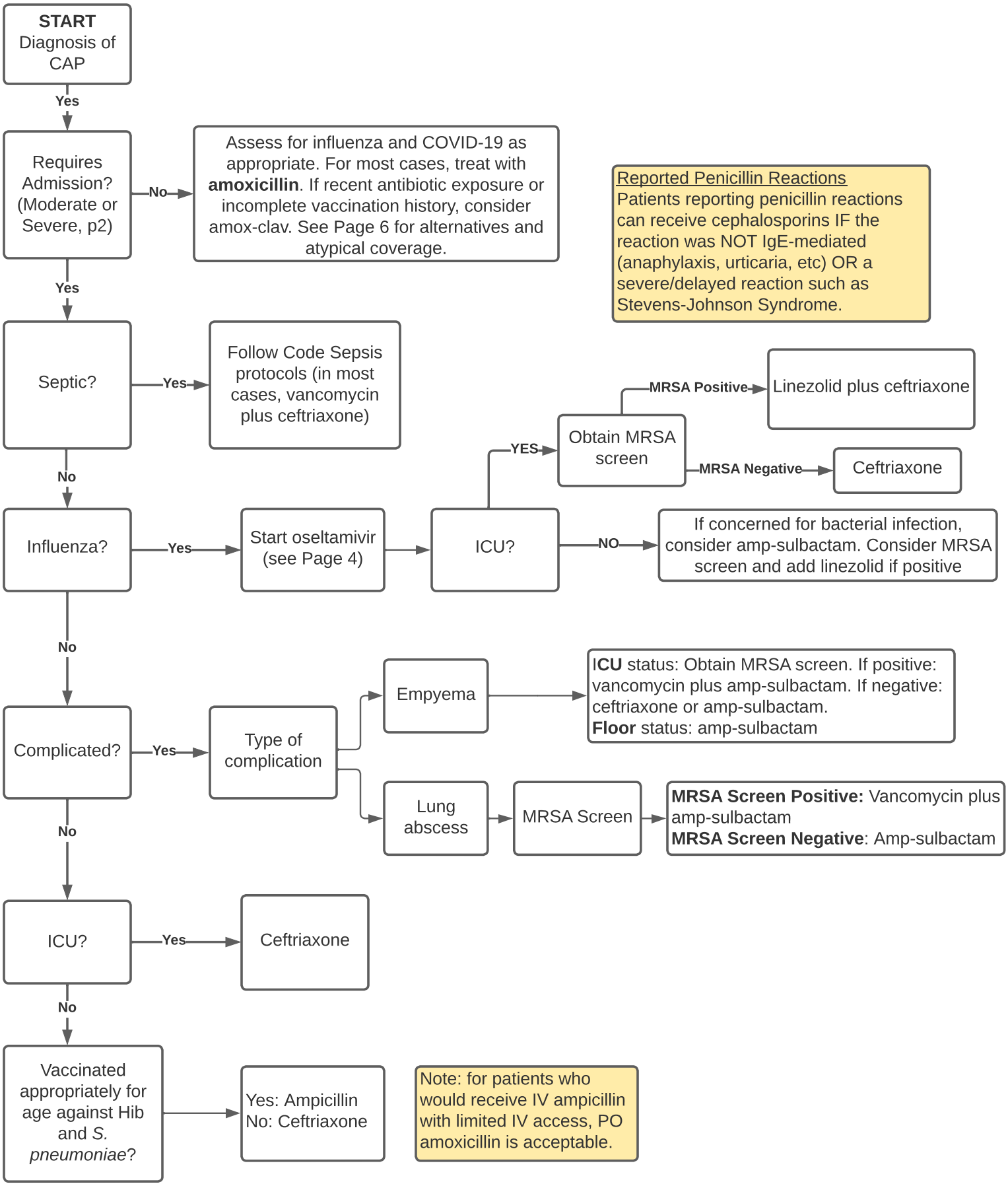
Page 5: Antibiotic Selection



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Pages 6-8: Antibiotic Selection, De-escalation, and Dosing

Table 1: Overview of Antimicrobial Selection for Children (1 month to 18 years) with CAP.

Patient Characteristics		MRSA Screen	Preferred Antimicrobial	Alternative Antimicrobial Therapy Options	Notes
Mild (Outpatient)	Fully immunized – at least 3 doses of Hib and PCV13, usually at 6-month visit	Not recommended	Amoxicillin	Recent exposure to amoxicillin (last 30 days): Amoxicillin/clavulanic acid Penicillin allergy: Clindamycin	Viruses and pneumococcus are most common causes. Oral cephalosporins are inferior to penicillins for pneumococci. Consider atypical infection in children ≥5 years of age (rare below 5 years)
	Incompletely immunized, including <6 months of age	Not recommended	Amoxicillin-clavulanate	Penicillin allergy: Clindamycin	*Haemophilus* may be more likely.
	Influenza positive, meets criteria for treatment	Not recommended	Oseltamivir	NA	Highest efficacy if oseltamivir started within 48 hours of symptom onset
Moderate (Inpatient, Floor)	Fully immunized (as above)	Not recommended	Ampicillin	Ceftriaxone Penicillin allergy: Clindamycin	
	Not fully immunized, not meeting "Severe CAP" criteria (Table 1), ≥ 1 month old	Not recommended	Ceftriaxone ADD oseltamivir if influenza positive.	Cephalosporin allergy: Levofloxacin	Underimmunization increases the patient's risk of infection caused by *Haemophilus influenzae* type b and *Streptococcus pneumoniae*.
	Influenza positive	May consider	Oseltamivir	If antibiotics indicated, ampicillin-sulbactam preferred. If MRSA (+), add linezolid.	Most patients with influenza do not require antibiotics.
	Complications: empyema or lung abscess	Lung abscess: yes Empyema: if critically ill	Ampicillin-sulbactam	Add linezolid if MRSA(+)	
Severe (PICU)	≥ 1 month old and admitted to PICU **without influenza or complications**	Obtain	Ceftriaxone. Add vancomycin if MRSA (+)	Ceftriaxone alternative: amp-sulbactam Vancomycin alternative: linezolid, clindamycin (less preferred)	Send ETT aspirate cultures from all patients at intubation (or ASAP) For patients with influenza and critical illness, MRSA coverage (linezolid preferred) is recommended regardless of MRSA PCR. If cultures do not show MRSA at 48 hours and MRSA PCR (-), usually OK to stop MRSA coverage.
	≥ 1 month old and admitted to PICU **with** influenza	Obtain	Oseltamivir PLUS ceftriaxone PLUS linezolid.	Clindamycin **OR** vancomycin may be used in place of linezolid if patient is unable to tolerate linezolid (e.g., thrombocytopenia, multiple serotonergic drugs)	
	Admitted to PICU **with complications** (empyema or lung abscess)	Obtain	Empyema: Vancomycin plus ceftriaxone Lung abscess: Vancomycin plus amp-sulbactam	If MRSA screen negative: stop MRSA coverage. Clindamycin OR vancomycin may be used in place of linezolid, as above.	

Table 2: IV to PO conversion/de-escalation

IV Antibiotic	Recommended PO Antibiotic	Notes
Ampicillin	High-dose amoxicillin	High-dose = 90 mg/kg/day of amoxicillin
Ampicillin-sulbactam	High-dose amoxicillin/clav	
Ceftriaxone	High-dose amox/clav Cefuroxime (preferred cephalosporin) Cefdinir	Amox/clav preferred if no penicillin allergy. Cefuroxime (or cefdinir) may be used in patients with penicillin allergy; cefuroxime is the preferred oral cephalosporin due to improved coverage of *Streptococcus pneumoniae* compared to cefdinir
Linezolid	Linezolid	In absence of positive culture or screen for *MRSA*, consider discontinuation of linezolid

Table 3: Recommended durations of therapy for common pneumonia syndromes

Syndrome	Recommended Duration
CAP without complications	5-7 days
CAP with empyema	2-3 weeks, or 2 weeks from definitive drainage
CAP with lung abscess	Individualized, often 4-6 weeks depending on clinical progress and inflammatory markers
Influenza	Oseltamivir x 5 days

Table 4: Antibiotic dosing recommendations

Antimicrobial	Dose	Max Dose	Route	Notes
Amoxicillin	90 mg/kg/day divided BID	2000 mg	PO	
Amoxicillin / clavulanic acid	90 mg amoxicillin/kg/day divided BID	2000 mg amoxicillin	PO	Dosing based on amoxicillin component. Recommended formulations: amoxicillin 600 mg / 42.9 mg clavulanate (14:1) (Not on inpatient formulary) amoxicillin 400 mg / 57 mg clavulanate suspension (7:1) amoxicillin 875 mg / 125 mg clavulanate tablet (7:1)
Ampicillin	200 mg/kg/day divided q6h	2000 mg	IV	
Ampicillin / sulbactam	200 mg ampicillin/kg/day divided q6h	2000 mg ampicillin	IV	Dosing based on ampicillin component
Azithromycin	10 mg/kg on day 1, followed by 5 mg/kg once daily for days 2 through 5	500 mg (day 1) 250 mg (days 2-5)	IV / PO	
Cefdinir	14 mg/kg/day BID	300 mg	PO	May be used in patients with severe penicillin allergy. Not preferred due to poorer activity against Pneumococcus compared to penicillins
Ceftriaxone	50 mg/kg once daily	2000 mg	IV	
Cefuroxime	30 mg/kg/day BID	500 mg	PO	Preferred cephalosporin for Pneumococcus; Suspension not on inpatient formulary, has unpleasant taste
Clindamycin	40 mg/kg/day divided TID	600 mg (IV) 450 mg (PO)	IV / PO	Doses > 450 mg may be given orally; however, GI distress may occur.
Doxycycline	2 mg/kg/dose BID	100 mg	IV / PO	
Levofloxacin	< 5 yo: 10 mg/kg BID ≥ 5 yo: 10 mg/kg daily	750 mg	IV / PO	May be used in patients with severe beta-lactam allergy (e.g., IgE-mediated reaction, anaphylaxis)
Linezolid	< 12 yo: 10 mg/kg TID ≥ 12 yo: 10 mg/kg BID	600 mg	IV / PO	
Oseltamivir	3 mg/kg/dose BID	75 mg	PO	Only use if influenza PCR test positive or if patient admitted to PICU with high concern for influenza
Vancomycin	15-20 mg/kg/dose q6-8h	2000 mg	IV	Place inpatient consult to pharmacy for vancomycin dosing & monitoring.